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POSSIBILITIES OF APPLYING MODERN PHOTOGRAMMETRY FOR THE MODERNIZATION OF CADASTRAL MAPS IN POLAND AND KAZAKHSTAN

MOŻLIWOŚCI WSPÓŁCZESNEJ FOTOGRAMETRII W MODERNIZACJI MAP KATASTRALNYCH W WARUNKACH POLSKI I KAZACHSTANU

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ABSTRACT: The development of digital photogrammetric technology, supported by the appearance of high resolution digital aerial cameras and new satellite imaging systems, has resulted in the transformation of the quality of photogrammetric products and their wide distribution. This has created new areas of interests, including their use for cadastral works. This paper discusses the issues related to the creation and modernization of cadastral maps in Poland and Kazakhstan. Extensive works in this field are performed in both countries: in Kazakhstan, this work results from systematic changes and in Poland, they are performed within the Governmental Programme of Development of an Integrated Real Estate Information System (ZSIN). Different conditions and demands for cadastral maps exist in both countries and they may be met by different technical means. In Kazakhstan, high resolution satellite images are useful. Their use has been fostered by two Earth satellite observation systems which were introduced two years ago. In Poland the conditions and demands dictate the use of high resolution aerial photographs. This paper discusses also in more detail the status of these works and demands, the existing capabilities of satellite imaging systems and the technical and organizational conditions relating to the use of contemporary photogrammetry for the modernization of cadastral maps in both countries.

1. INTRODUCTION

About 20 years ago digital photograph processing technologies emerged on the market; the "digital photogrammetry" epoch was started and it is developing still. Initially, analogue aerial photographs (on rolls of films) were the weak point in digital technologies.

It was necessary to scan such photographs before they could be used as input data for digital photogrammetric processing. This soon changed; after the year 2000 aerial digital cameras appeared and started to gain prominence on the market. The appearance of digital photogrammetry was the major breakthrough. It could seem that changing analogue photographs into digital form was a technical operation only, considering that the "photogrammetric core" of the next stages remained unchanged. So what is the key to the attractiveness of digital photogrammetry and its indubitable success? The answer is: automation.

Processing digital photographs allowed the process to be automated. Even the observation of photographs may be automated using image matching techniques. These techniques are similar to those of computer vision, as often applied in robotics. The automation of observations is a key capability in the automation of aerial triangulation. Advanced computer technology enables the connection of several thousand photographs into blocks and their adjustment, all in a single technological process. The process of developing digital terrain models is almost completely automated; it is based on the spatial measurements of up to several hundred thousands of points per photograph. The process of developing digital orthophotomaps, which are the most popular cartographic products, is also highly automated.

Contemporary photogrammetry, including digital photogrammetry, is not limited to processing aerial photographs. Another source of data whose importance has been rapidly growing is airborne laser scanning (ALS). Satellite image data are also becoming more important. The discussed data sources are the subject of interest of digital photogrammetry and their digital form is perfectly suited to automation of further data processing.

This paper aims to identify the contemporary measuring capabilities of digital photogrammetry based on digital photographs and satellite images. It also aims to serve as a reference of those capabilities for surveys and cartographic works performed to meet the needs of the modernization of cadastral maps. Those capabilities will be distinct in the differing conditions which exist in Kazakhstan and Poland.

2. THE CURRENT CONDITIONS OF MAINTAINING THE CADASTRE IN KAZAKHSTAN

Compared to Poland, Kazakhstan is a large country. It is 2 724 900 sq.km (almost nine times bigger than Poland) which, in the field of cadastre, took over the legacy left after the disintegration of the Soviet Union. This legacy includes very large farms owned by the state. Transformation of the state property into cooperative and private property runs slowly. This results in new challenges in the field of creating, maintenance and updating the cadastre and cadastral maps.

The state cadastre uses special analogue topographic maps on a fixed basis (plates). For agricultural areas maps with scales of 1:10 000 and 1:25 000 are mainly used. Those maps are not updated in practice; their content corresponds to 1990. In the case of special localities, large-scale maps (1:2000) are applied. Those maps are accessible for regional centres, for cities, district centres and selected places in villages only. Most rural areas maps were updated in the period 2003-2006.

Those maps were scanned in the automated state cadastre and they are stored in the form of raster maps (bitmaps), referenced to the selected geodetic coordinates system.

In some cases raster maps are digitized and stored as vector layers. However, these vectorized maps constitute a relatively small fraction of map resources. Information concerning parcel lines is entered as vector layers based on special maps. Information concerning cadastral numbers, coordinates of parcel lines, owners and documents which confirm the property status is entered as attribute data. Those maps are partially updated, according to their financial potential. Topographic measurements of a parcel are now required for the issuing of documents concerning the property title. In this way, local authorities have recently solved the problem of updating maps at the local level. However, updating the map coverage still requires a wider approach.

There are many aspects to consider; the size of the country, the size of parcels in rural areas and the intensity of changes; as well as related demands to maintain the cadastre including the development of cadastral maps, the legacy after the Soviet Union and delays in updating the maps and increasing their coverage. The solution may be offered by satellite images. It may be justified in both technical as well as economic terms. Kazakhstan has been using two satellite imaging systems (remote sensing satellites), KazEOSAT-1 and KazEOSAT-2, with high and medium resolution respectively. This offers new opportunities to update maps, including cadastral maps. Considering those opportunities it is possible to update topographic maps within 5-year cycles.

3. THE KAZAKHSTAN SATELLITE EARTH OBSERVATION SYSTEM

In 2009, EADS Astrium was selected by JSC (Joint-Stock Company National Company ”Kazakhstan Gharysh Sapary“ - KGS), charged with the development of Kazakhstan’s space program, on behalf of Kazcosmos (Kazakhstan National Space Agency) to develop an “Earth Observation Satellite System” consisting of two missions, namely a HRES (High Resolution Earth Observation Satellite) and MRES (Medium Resolution Earth Observation Satellite) mission. KGS is a division of Kazcosmos, located in Astana, Kazakhstan.

The overall system comprises two satellites. During their development phases, the two projects were initially referred to as HRES (High Resolution Earth Observation Satellite) and MRES (Medium Resolution Earth Observation Satellite). Just prior to the launch of the first spacecraft (in April 2014), KGS switched the names of the two missions:

- KazEOSat-1 (High Resolution Earth Observation Satellite System) built by Astrium SAS of Toulouse, France (Pan spatial resolution of 1 m)
- KazEOSat-2 (Medium Resolution Earth Observation Satellite) provided by SSTL of Surrey, UK (spatial resolution of 6.5 m).

3.1 KazEOSat-1 - High Resolution Earth Observation Satellite System

The main purposes of the high performance 1 m resolution system and the program in general are to provide the governmental and commercial users in Kazakhstan with regularly updated imagery of the country, and to build the national capability in design and development of satellites and ground segments for future missions through an extensive hands-on know-how technology transfer program. The KazEOSat-1 spacecraft was built by Airbus Defense and Space (formerly Astrium SAS) of Toulouse, France. The spacecraft is based on the same product line as SPOT-6 and SPOT-7 (Table 1). The spacecraft acquired the first images of Kazakhstan on May 5, 2014 (Figure 1).

Table 1. Main system parameters of KazEOSat-1

Spacecraft launch mass	830 kg
Spacecraft size	2.1 m x 3.7 m
Spacecraft design life (nominal)	7.25 years
Power generation	1.2 kW (BOL)
Spacecraft agility	Up the 35º off-nadir angle into any direction, 60º slew in 90 s
Delta-V capacity	180 m/s
Payload data downlink rate	270 Mbit/s
GSD (Ground Sample Distance)	1 m (Pan), 4 m (MS) on a swath of 20 km
Daily observation coverage	220 000 km^2

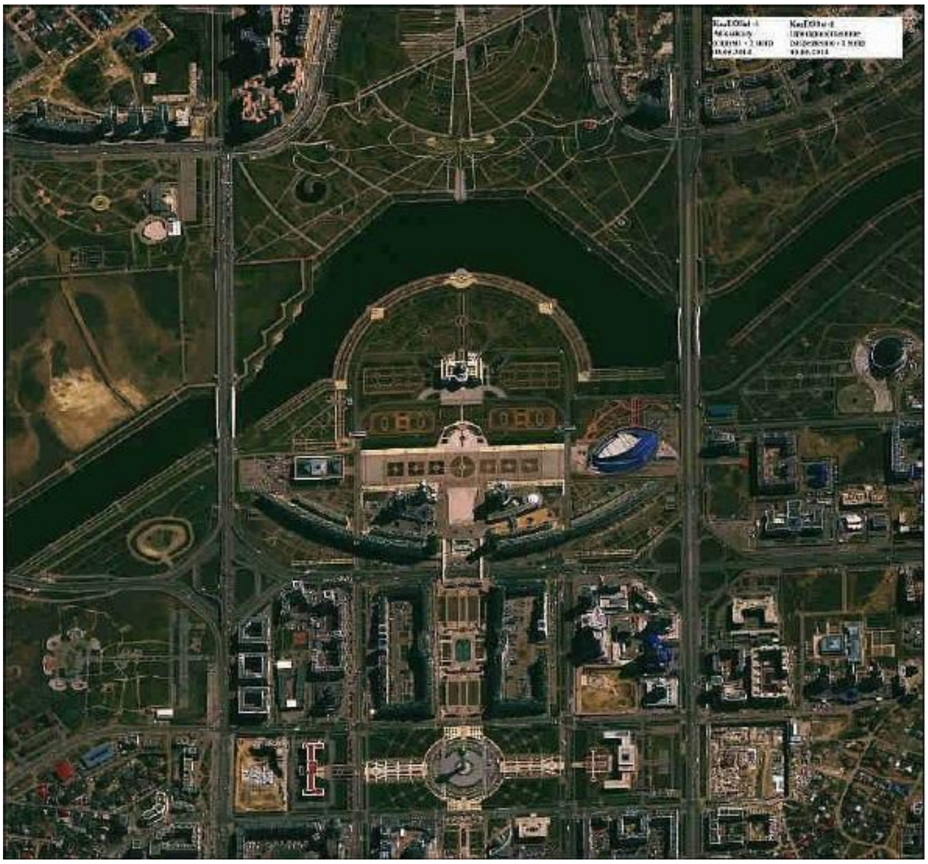

Fig. 1. First image of Astana, the capital of Kazakhstan, acquired with KazEOSat-1 on May 5, 2014 with a 1 m resolution (https://directory.eoportal.org/web/eoportal/satellite-missions/k/kazeosat-1)

Launch: The KazEOSat-1 spacecraft was launched on April 30, 2014 (1:35:15 UTC) on a Vega vehicle (flight VV03) of Arianespace from the Guiana Space Center, French Guiana. Vega's payload mass for this launch was 918 kg, of which 830 kg was the satellite. KazEOSat-1 was released into its designated orbit 55 minutes and 29 seconds after launch. Orbit: Sun-synchronous near-circular orbit, nominal altitude 750 km, inclination 98.54º, period 100 minutes, LTDN (Local Time on Descending Node) 10:30 hours.

Geolocation accuracy: Approximately 1 m planimetric accuracy across the scene with ground control points. Better than 15 m (1σ RMS) without ground control points.

Mission: The KazEOSat-1 spacecraft is sun-pointing during portions of the sunlit orbit for power generation. The attitude is geocentric during imaging sessions (up to 35° off-nadir) and contacts with the ground segment. The maximum duration of imaging per orbit is 10 minutes, the average duration is 3 minutes. The maximum length of a strip imaging is 2000 km. The agility of the satellite allows performing one-pass 3-strip area and stereo imaging in one pass with the width of the synthetic mosaic scene of 60 km, and length 90 km, and stereo imaging.

Sensor complement: NAOMI (New AstroSat Optical Modular Instrument): NAOMI is a high-resolution pushbroom imager designed and developed at Airbus. The instrument design is mainly driven by mission parameters and detector characteristics. The key NAOMI parameters are summarized in Table 2.

Table 2. Specification of the NAOMI (New AstroSat Optical Modular Instrument) instrument

Instrument type	Pushbroom imager
Optics	Korsch telescope in SiC (Silicon Carbide), aperture diameter 640 mm
Spectral band (Pan)	0.45-0.75 μm
MS (Multispectral bands), 4	Blue: 0.45-0.52 μm Green: 0.53-060 μm Red: 0.62-0.69 μm NIR: 0.76-0.89 μm
GSD (Ground Sample Distance)	PAN: 1.0 m at nadir MS: 4 m at nadir
TDI (Time Delay Integration)	The PAN band offers TDI services for SNR improvement of the signal
Swath width	20 km at nadir
FOR (Field of Regard)	±35º (spacecraft tilting capability about nadir for event monitoring)
Data quantization (dynamic range)	12 bit
Instrument nominal mass	150 kg (telescope + electronics)

3.2 KazEOSat-2 - Medium Resolution Earth Observation Satellite System

The key objectives of the KazEOSat-2 mission can be summarized as follows:

- To provide a state-of-the-art medium resolution imaging satellite and the accompanying ground segment to KGS,
- To provide a 7 year operational lifetime,
- To provide agile imaging modes,

– To be capable of imaging up to 1 000 000 km^2 per day.

The KazEOSat-2 spacecraft will aid the government of Kazakhstan in decision making when it comes to resource monitoring, resource management, land-use mapping and environmental monitoring. This satellite was delivered by SSTL within a 3 year timeframe which included a comprehensive training and development element, by building upon its heritage designs from its successful SSTL-150 class missions. The architecture of KazEOSat-2 is similar to that of the RapidEye spacecraft. The main differences are the enhanced agility enabling stereo and area imaging with the new generation Rigel-L star trackers and 100SP-M reaction wheels.

In addition to the above key mission objectives, more specific details have been defined. These key mission performance parameters are summarized in Table3.

Table 3. Summary of the key KazEOSat-2 mission performance

Mission operations	7 year operational lifetime
Spacecraft launch vehicle	Dnepr
Launch mass	~185 kg
OAP (Orbit Average Power)	55 W
Spacecraft envelope	700 mm x 800 mm x 900 mm
Design orbit	Sun-synchronous orbit, altitude630 km
Imager GSD (Ground Sample Distance)	6.5 m
Spectral bands	5 (blue, green, red, red edge & NIR)
Swath width	77 km
Observation area per day	1,000,000 km2
Downlink data rate	160 Mbit/s
Agile spacecraft with an off-pointing capability	±35º off nadir (60º slew in 90 seconds)
Delta-V capacity	> 30 m/s
Ground station location	Astana, Kazakhstan

Launch: The KazEOSat-2 minisatellite (~185 kg) was launched on June 19, 2014 (19:11:11 UTC) on a Dnepr-1vehicle of ISC Kosmotras. The launch site was the Yasny Cosmodrome in the Dombarovsky region of Russia.

Sensor complement: KEIS (Kazakh Earth Imaging System):is a multispectral imaging system of RapidEye constellation heritage, designed and developed by JOP (Jena-Optronik GmbH), a subsidiary of the Photonics Division of Jenoptik), Jena, Germany. The instrument is also referred to as JSS-56 (Jena-Optronik Spaceborne Scanner-56) as well as MSI (Multispectral Imager) in the literature. The collector optics utilizes a TMA (Three Mirror Anastigmatic) design. KEIS is a pushbroom instrument which images the Earth's surface in 5 spectral bands over a swath width of 78 km (corresponding to a FOV of ± 6.75º about nadir) at a spatial resolution of 6.5 m at nadir (Table 4). The collector optics image on to five parallel linear 12k pixel CCD detectors. Filters, placed in close proximity to each CCD line array, separate the spectral imaging bands. The key KEIS instrument parameters are summarized in Table 5.

Table 4. Spectral parameters of KEIS

Band number	Band name	Spectral coverage (nm)	Center wavelength (nm)
1	Blue	440-510	475.0
2	Green	520-590	555.0
3	Red	630-685	657.5
4	Red edge	690-730	710.0
5	NIR (Near Infrared)	760-850	805.0

Table 5. Overview of KEIS instrument parameters

KEIS instrument mass	43 kg (imager + electronics box)
Peak power consumption	93 W (simultaneous image take & downlink)
Instrument size	Imager: 656 mm x 361 mm x 824 mm Payload Interface Unit (PIU): 280 mm x 242 mm x 260 mm
Optics, aperture, f/No, focal length	TMA (Three Mirror Anastigmatic) design, 145 mm diameter, f/4.3, effective focal length 633 mm
FOV	± 6.75º about nadir, corresponding to a swath of > 70 km at an orbital altitude of 630 km
IFOV	6.5 m (spatial resolution), orthorectified pixel size 5 m
MTF (ModulationTransfer Function)	≥ 0.25 in along-track, ≥ 0.11 in cross-track
Detector (pushbroom type)	CCD linear array with 12 k pixels (5 arrays in parallel, 1 for each spectral band), use of triple line CCDs with 3 x 12 k pixels in a ceramics baseplate, pixel size 6.5 μm
Data quantization	12 bit

The KazEOSat-2 spacecraft provides the following imaging modes:

- Image strip: An image strip is composed of individual image ‘scenes' that are 77 km x 77 km in size which can be used for applications such as mapping. The maximum length of an image strip is 4000 km and it can be captured a troll angles of up to 35º from nadir.
- Stereo mode: The stereo mode is used to capture the two stereo images of an area of interest which can provide height information of the target area. Each stereo image comprises a pair of images taken of the same location but at different view angles. These two fully overlapping image scenes are captured at pitch angles of 30º, with the first scene captured before the spacecraft reaches the target and the second image taken after the satellite has passed overhead.
- Mosaic mode: Mosaic mode is used to capture wide swath imagery and comprises of two adjacent image scenes. The mode operates in a very similar way to the stereo mode. The only difference is that the scenes imaged are adjacent and not fully overlapping.

4. THE ASSESSMENT OF POSSIBILITIES OF MEASURING CADASTRAL PARCELS IN KAZAKHSTAN CONDITIONS

In Kazakhstan the agreed scale of maps for agricultural areas is 1:10 000 (or even 1:25 000). The required accuracy of measurements of parcel lines is 2.0 m. Since they have not been updated, existing topographic maps in analogue form are not useful, particularly when dynamic changes to the borders of agricultural parcels are considered.

The size of the country, the growing demands for solving the problem and recent possibilities of accessing satellite images, all point to satellite images being the source data which will enable a relatively fast solution to the problem of cadastral maps, at the required technical level. Kazakhstan has two advanced satellite imaging systems: the high resolution system which has a 1m pixel size and the medium resolution system which has a 6.5 m pixel size. Both systems enable the generation of an orthophotomap in true colours (RGB) or a colour-infrared (CIR) orthophotomap with a pixel size of 1 and 5 m respectively.

The broad experience of the orthorectification of satellite images indicates that orthophotomaps generated in practice are characterized by the location accuracy (the positioning error) at the level of their resolution (i.e., a pixel of an orthophotomap). From the technological point of view, such products may be easier and cheaper to generate than an orthophotomap generated from aerial photographs (Kurczyński *et al*., 2005). Finally, the high resolution satellite images, with 1 m pixel size, acquired from KazEOSAT-1 system are an excellent source for the generation of orthophotomaps with a 1m pixel size. Measurements of parcel lines performed on such orthophotomaps would even exceed the required accuracy (the positioning error 2 m).

Images acquired by the KazEOSAT-2 system, with a pixel size of 6.5 m, might be also applied; they enable the generation of an orthophotomap with a 5 m pixel size. This system is more efficient and it allows for faster and cheaper generation of orthophotomaps. Such products might be utilized as the source data for updating topographic maps at the scale of 1:25 000 (Kurczyński, Wolniewicz, 2006); it could also be the reference background for assessing the quality of existing cadastral data (i.e., the accuracy of existing borders, their timeliness and completeness). This could indicate areas which should be urgently covered by modernization works in the field of the cadastre.

In resident areas (built-up areas, localities and cities) where a higher accuracy of measurements of parcel lines is required (the positioning error must be under 0.20 m), an orthophotomap generated from high resolution aerial photographs would be required.

5. POSSIBILITIES OF USING PHOTOGRAMMETRIC METHODS FOR THE MODERNIZATION OF THE LAND AND BUILDINGS REGISTRATION IN POLAND

The cadastre is undoubtedly the most important and oldest public registry maintained by districts with the strong support of private land surveyors and the survey industry. From technical point of view, the cadastre is divided into two parts: the descriptive part and the cartographic part (cadastral maps).

Districts in Poland are in the process of “modernization of the cadastre”. This consists of taking new measurements of land parcel lines, new measurements of the outlines of buildings, unification of coordinate systems, etc. The modernization (an update) of the cadastre is a substantial body of work being carried out by surveying companies. It should be added that a scattered geometric structure exists in Poland which, in total, includes about thirty million arable lots, being the property of approximately three million farmers. In most cases parcels lines are not fixed on the ground. In terms of the required precision, these works are among the most accurate. Positions of corner points of cadastral parcels in relation to surveying controls of the 1st class should be determined by means of surveying topographic measurements with mean errors which do not exceed 0.30 m; for the corners of buildings the required precision is characterized by having measurement accuracy no worse than 0.10 m in relation to the nearest points of a control or a minor control network. Considering the accuracies of minor control networks than the 1st class; geometric data concerning corners of buildings must also meet the criteria of 0.30 m accuracy, when they refer to the 1st class control network. These requirements are very high.

Within the last few decades the possibilities of photogrammetry have been dramatically changed, together with the emergence of digital photogrammetry. As a result of the introduction of digital cameras and automation of photogrammetric technologies, photogrammetric measurement methods have been taken to a new level, in both technical and economic aspects. Considering the challenges in the field of modernization of the land and buildings registry, the question should be asked whether contemporary photogrammetry may contribute to this process. Binding legal regulations allow the use of photogrammetry as a source of registration data and specify "geodetic photogrammetric measurements" (3D stereodigitizing on a photogrammetric station) and "geodetic cartographic measurements” (2D measurements on a digital orthophotomap). However, more precise guidelines do not exist in this area.

There are many examples of tests presenting the possibilities of using photogrammetric methods for that purpose (Kuklicz, Kuźnicki, 2015; Kurczyński, Bakuła, 2015; Kurczyński *et al*., 2016; Srinivas*et al*., 2012). Recently, large scale photographs acquired with the use of large format digital cameras have been increasingly utilized. Photogrammetric methods are applied at various different stages of the modernization of the cadastre. Some limitations are caused in this case by binding legal regulations and legal-and-technical difficulties resulting from historical conditions.

It may be noticed that the approximate accuracy of photogrammetric works depends proportionally on the scale of photographs and, at present, on the field pixel size (GSD). The accuracy of work is thus coded in this parameter. Agricultural engineering works consider cadastral objects (parcel lines and outlines of buildings, exclusively) as the most important details and they impose high accuracy requirements concerning their measurements. Buildings are the 1st class objects and their accuracy should equal to 0.1 in relation to the control network. Transposing this to photogrammetry it means that we should deal with photographs of very high resolution, from the interval GSD = 0.05 ÷ 0.10 m, often with the lateral overlap of photographs increased to 60%. These are the highest resolution values of aerial photographs applied in practice.

Geodetic cartographic measurements are legally understood as 2D measurements on a digital orthophotomap, which is a set of photographs processed from central to orthogonal projection. Specific features of photogrammetric processing, including a digital orthophotomap, include its development into one uniform technological process for an entire object covered by hundreds or even thousands of photographs. This ensures the uniformity and internal coherence for the entire area of data processing. As a result, the digital orthophotomap is an ideal product to be used for verification of the accuracy of other products.

When modernization of the land and buildings registration is performed, measurements of parcel lines are also carried out. It may also be performed using a digital orthophotomap. Such measurements should be classified into the geodetic cartographic measurements. However, the scope of such measurements is limited by the lower measurement accuracy than the accuracy of measurements of a model, generated from the same, original photographs. The location accuracy of the digital orthophotomap (the accuracy of position of an object image) depends on resolution capabilities of output photographs, i.e., the pixel GSD of photographs acquired by digital cameras. The error consists of residual errors in the orientation of photographs and DTM errors. The influence of DTM errors may be reduced by processing (orthorectifying) a part of a photograph, limited to its central fragment. Additionally, the lateral overlap of photographs may be increased; this also limits orthorectified fragments of photographs to central fragments. The use of a DTM of higher accuracy leads to an increased positioning accuracy of orthophotomaps. This solution is currently viable in Poland due to the availability of precise DTM generated from aerial laser scanning data within the ISOK Project (ISOK - the IT system of the Country's Protection Against Extreme Hazards).

When the digital orthophotomap is considered as a source material for measurements of parcel lines, the high requirements concerning the field photogrammetric network and precise adjustment of aerial triangulation are still valid. It may be expected that in practice the positioning error on a digital orthophotomap will be equal to 2.0 ÷ 2.5 GSD. In the case of photographs with GSD = 0.10 m this would mean a location error of 0.20 ÷ 0.25 m. This error is greater than those involved in spatial (3D) measurements on a stereoscopic model. When a parcel line in a form of a balk or a fence is measured, this error will be slightly increased by the error in the identification of a balk centre, as a parcel line. In the case of photographs of a higher resolution (the smaller GSD value), errors of measurements will be proportionally smaller.

To measure buildings with the assumed accuracy is a more challenging task than the measurement of parcel lines. "Geodetic photogrammetric measurements" are required, i.e., spatial measurements of a photogrammetric model generated from aerial photographs. Photographs of the highest resolutions are required in this case, with a pixel size of GSD=0.05 ÷ 0.10 m and the lateral overlap increased to 60%. Such photographs enable the visibility and spatial measurements of all corners of buildings (Kurczyński *et al*., 2016).

6. FINAL REMARKS

This paper presents issues related to the implementation of geodetic cadastral works using the example of two countries: Poland and Kazakhstan. These represent completely different conditions and current statuses of the cadastre. In both cases the use of photogrammetric methods is technically and economically justified, although with the use of different photogrammetric techniques, which correspond to the distinct local demands and possibilities.

In the case of Kazakhstan, the development of the cadastre based on orthophotomaps generated from high resolution satellite images may be the answer to rapidly growing demands for cadastral maps and delays existing in this field. This scenario is enhanced by the fact that Kazakhstan has recently commenced its own programme of satellite imaging with parameters corresponding to the requirements of cadastral maps.

A completely different situation occurs in Poland where large-scale works in the field of modernization of the land and buildings registration are performed within the Governmental Project "The Development of an Integrated Real Estate Information System (ZSIN). It is apparent from past experiences that photogrammetric methods may be useful at different stages of that process, in particular in the case of large areas. Very high resolution aerial photographs (pixel size GSD = 0.05 ÷ 0.10 m) and increased lateral overlap are particularly useful for such purposes.

LITERATURE

Kuklicz P., Kuźnicki W. 2015. Zdjęcia lotnicze – skuteczna metoda na EgiB. *Magazyn geoinformacyjny Geodeta*, 6/2015, pp. 18-20.

Kurczyński Z., Wojtynek R., Wolniewicz W. 2005. Evaluation of Usefulness of the VHRS Images for Elaboration of the Topographic Data Base (TDB). International Geographic Information Systems Conference and Exhibition, „GIS Odyssey 2005". Geographic Information Systems in Research & Practice, II-nd Part, pp. 29-37.

Kurczyński Z., Wolniewicz W. 2006. Assessment Of The VHRS Images For Elaboration of The Topographic Data Base 1:10 000 In Poland. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 36 (1).

Kurczyński Z., Bakuła K. 2016. Ocena możliwości współczesnej fotogrametrii w pracach z zakresu ewidencji gruntów i budynków. *Przegląd Geodezyjny*, 7/2016, s. 2-9.

Kurczyński Z., Bakuła K., Karabin M., Kowalczyk M., Markiewicz J., Ostrowski W., Podlasiak P., Zawieska D. 2016. The possibility of using images obtained from the UAS In cadastral works. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 41 (B1), pp. 909-916.

Rozporządzenie Ministra Administracji i Cyfryzacji z dnia 29 listopada 2013 r. w sprawie ewidencji gruntów i budynków (Dz. U. z 2013 r., poz. 1551).

Srinivas, P., Venkataraman V. R., Jayalakshmi I. 2012. Digital Aerial Orthobase for Cadastral Mapping. *Journal of the Indian Society of Remote Sensing*, 40(3), pp. 497-506.

https://directory.eoportal.org/web/eoportal/satellite-missions/k/kazeosat-1
https://directory.eoportal.org/web/eoportal/satellite-missions/k/kazeosat-2

MOŻLIWOŚCI WSPÓŁCZESNEJ FOTOGRAMETRII W MODERNIZACJI MAP KATASTRALNYCH W WARUNKACH POLSKI I KAZACHSTANU

SŁOWA KLUCZOWE: kataster, mapy katastralne, obrazowania satelitarne, zdjęcia lotnicze, fotogrametria cyfrowa

Streszczenie

Zaistnienie technologii cyfrowych w fotogrametrii, wsparte wejściem na rynek wysokorozdzielczych lotniczych kamer cyfrowych i nowych systemów obrazowania satelitarnego spowodowało jakościowy skok produktów fotogrametrycznych, połączony z ich upowszechnieniem. Stworzyło to nowe obszary zastosowań, m.in. w zakresie prac katastralnych. Artykuł stanowi spojrzenie na problemy zakładania i modernizacji map katastralnych na przykładzie Polski i Kazachstanu. W obu krajach trwają intensywne prace w tym zakresie: w Kazachstanie jest to spowodowane zmianami ustrojowymi, a w Polsce Rządowym Programem Rozwoju Zintegrowanego Systemu Informacji o Nieruchomościach (ZSIN). Różne w obu krajach warunki i zapotrzebowanie w zakresie prowadzenia map katastralnych mogą być zaspokajane różnymi środkami technicznymi. W warunkach Kazachstanu przydatne są wysokorozdzielcze obrazy satelitarne. Sprzyjają temu uruchomione dwa lata temu dwa systemy obserwacji satelitarnych Ziemi. W warunkach krajowych będzie to opracowanie wysokorozdzielczych zdjęć lotniczych. Artykuł przybliża stan prac i potrzeb, zaistniałe możliwości systemów obrazowania satelitarnego oraz uwarunkowania techniczne i organizacyjne wykorzystania współczesnej fotogrametrii w modernizacji map katastralnych w obu krajach.

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